ESC European Society of Cardiology

European Heart Journal - Case Reports (2020) **4**, 1–2
doi:10.1093/ehjcr/ytaa019

IMAGES IN CARDIOLOGY
Arrhythmias/electrophysiology

Visualization of transmural wave propagation using simultaneous endo-epicardial mapping

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Received 12 November 2019; first decision 30 November 2019; accepted 16 January 2020; online publish-ahead-of-print 6 March 2020

Introduction

Atrial excitation, whether during sinus rhythm or atrial fibrillation (AF), is a complex three-dimensional process. Recent studies indicate an important role of transmural wave propagation from endo- to epicardium or vice versa in AF, potentially resulting in focal activation patterns.[1] Epicardial activation may differ significantly from endocardial activation resulting in endo-epicardial asynchrony (EEA). Until now, transmural wave propagation was described in either the two-dimensional endo- *or* epicardial plane. As demonstrated previously, endo- and epicardial mapping together may provide more guidance for the ablation strategy.[2] Simultaneous endo-epicardial mapping enables us to investigate three-dimensional wave propagation, thereby providing more insights in the mechanisms underlying AF.

Mapping procedure

Simultaneous endo-epicardial mapping during sinus rhythm was performed of the superior right atrium (*Figure 1*). Local activation times (LATs) were determined by annotating the steepest deflection per electrode. In addition, activation waves were reconstructed using derivatives of raw potentials. Written informed consent was obtained before surgery.

Visualization of transmural wave propagation

Supplementary material online, *Video S1* illustrates activation of the endo- and epicardium using LATs and activation waves constructed from raw potentials. In the right panel, blue and red colour indicate negative and positive slopes of the electrogram, respectively. Hence, blue areas indicate activation waves and red areas indicate repolarization. Light blue areas indicate negative slopes, which are not as steep as the steepest negative slope (e.g. far-field). At $t = 2$ ms, a focal wave appears at the centre of the epicardial electrode array. A second wave enters from the right side at $t = 8$ ms curving around the area activated by the focal wave. As clearly visualized using the reconstructed activation waves, at $t = 5$ ms a wave appears at the endocardium. The preceding endocardial light blue area represents most likely a transmurally approaching wave from the epicardium. Similar wave propagation patterns resulting in two consecutive endocardial focal waves are seen at $t = 12$ ms and $t = 20$ ms.

This case clearly visualizes that determination of transmural excitation using raw potentials together with LATs might provide more insight in transmural wave propagation patterns. Our group has shown that, during AF, a significant degree of EEA is present in the right

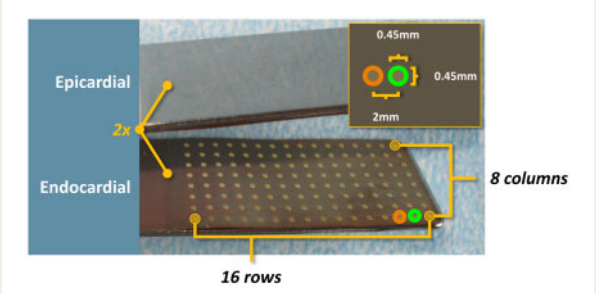

Figure 1 Mapping clamp containing two electrode arrays. Both arrays have 16 rows and 8 columns of electrodes with a diameter of 0.45 mm and an inter-electrode spacing of 2 mm. Simultaneous endo-epicardial mapping was performed of the superior right atrium.

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Handling Editor: Philipp Sommer

Peer-reviewers: Konstantinos Iliodromitis and Henning Jansen

atrium of patients with AF, potentially resulting in complex conduction patterns as a consequence of transmural wave propagation.[1] This case showed that transmural wave propagation is already present during sinus rhythm, hence differences in transmural wave conduction patterns presumably are a key element in the mechanisms underlying AF.

Supplementary material

Supplementary material is available at *European Heart Journal - Case Reports* online.

Consent: The author/s confirm that written consent for submission and publication of this case report including image(s) and associated text has been obtained from the patient in line with COPE guidance.

Conflict of interest: none declared.

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